Groundwater recharge and trends: comparative analysis of sedimentary and basement aquifers in Benin

Results obtained thanks to GRIBA project

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PLAN

• INTRODUCTION

• METHODOLOGY

• RESULTS

• CONCLUSION AND OUTLOOKS
INTRODUCTION

• Groundwater in Benin
  – Main resource for domestic needs
  – 950 new boreholes/year (1996-2012)
  – Recharge poorly known
    ✓ Quantification
    ✓ Trend
INTRODUCTION

• Groundwater in Benin
• This study aims at:
  – Quantifying the recharge
    ✓ Hard rocks (Precambrian)
    ✓ Mio-pliocene (Continental Terminal)
    ✓ Quaternary sediments
  – Analyzing the trend in recharge
    ✓ Longer chronicles of SWL in Benin
    ✓ Medium frequency measurement time step
MATERIAL AND METHOD

• Material
  – 3 chronicles of 17-25 years
  – 10-days time step
  – Rainfall records (located at 0-14 km)
MATERIAL AND METHOD

- Material
- Method
  - Water Table Fluctuation Method

\[
R_{\Delta t} = \left( \frac{\Delta H^+}{\Delta t} + \frac{\Delta H^-}{\Delta t} \right) \cdot S_y
\]

- \( R_{\Delta t} \) = Recharge during \( \Delta t \)
- \( \Delta H^+ \) = Positive WL variation
- \( \Delta H^- \) = Groundwater outflow
- \( S_y \) = Specific yield
MATERIAL AND METHOD

• Material

• Method
  - Water Table Fluctuation Method
  - Trend analysis
    • Linear trend
    • Mobile average (5 years)
    • Standardized index: \( SPI = \frac{X_i - X_m}{S_i} \)

\( Xi = \text{annual rainfall} \)
\( Xm = \text{mean rainfall} \)
\( Si = \text{Standard deviation} \)
RESULTS

- Quaternary sediments (unconsolidated sandstone)
  - \(170\text{mm} < \text{Recharge} < 700\text{mm}\)
  - \(\text{Recharge} = 34\%\) of Rainfall (annual)

Annual recharge strongly controlled by rainfall
RESULTS

• Quaternary sediments (unconsolidated sand)
  – 170mm < Recharge < 700mm
  – Recharge = 34% of Rainfall (annual)
  – Trend 1991-2014:
    ➢ Rainfall → +13 mm/year
    ➢ Recharge → +11 mm/year

Annual recharge strongly controlled by rainfall
Trend in recharge controlled by trend in rainfall
RESULTS

• Continental Terminal (Sandstone)
  – 38mm < Recharge < 580mm
  – Recharge = 21% of Rainfall (annual)
  – Trend 1994-2014:
    ➢ Rainfall \( \rightarrow \) +16 mm/year
    ➢ Recharge \( \rightarrow \) +7 mm/year

Annual recharge strongly controlled by rainfall
Trend in recharge controlled by trend in rainfall
RESULTS

• Hard rock
  – 56mm < Recharge < 85mm
  – Recharge = 6% of Rainfall (annual)
  – Trend 1997-2015:
    ➢ Rainfall \(\rightarrow\) +1.5 mm/year
    ➢ Recharge \(\rightarrow\) -0.8 mm/year

Groundwater storage in equilibrium with rainfall
No trend
CONCLUSION AND OUTLOOKS

• Conclusion
  – Recharge $\rightarrow$ geology
  – Recharge $\rightarrow$ rainfall
  – Trend in recharge $\rightarrow$ trend in rainfall

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CONCLUSION AND OUTLOOKS

• Conclusion
  – Recharge → geology
  – Recharge → rainfall
  – Trend in recharge → trend in rainfall

Aquifer storage vulnerable to rainfall change

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• Outlooks
  – Link geology/recharge?
  – Linear process (recharge/rainfall)?
THANKS